

Wachusett Dam - 100 Years Old



Wachusett Dam then and now. Completed in 1905 at left looking east and today, looking west, holding back 65 billion gallons of water.

The one hundredth anniversary of the laying of the last stone in the construction of the Wachusett Dam will take place on June 24, 2005. The undertaking of a massive public works project can take years and the building of this dam, with only the power of man and horse, was no exception. The Metropolitan Water Board was formed in 1895 and given broad powers to find the solution for what had become an urgent problem. The urbanized hub of central New England's commerce had nearly exhausted the existing water supplies of Spot Pond, the Cochituate Reservoir, and the multi-reservoir Sudbury System. This challenge needed quick resolution; the problem was resolved in a relatively timely fashion with world-class notoriety. The facts, figures and images in the following pages tell the story of the ten year process of constructing the Wachusett Dam.

DCR, New Name, But Our Mission Remains Unchanged

The Department of Conservation and Recreation (DCR) was created in July 2003 when the legislature merged the Metropolitan District Commission (MDC) and the Department of Environmental Management (DEM). Chapter 26 of the Acts of 2003, s. 290 transferred the responsibilities of the former MDC Division of Watershed Management entirely to the Office of Watershed Management within the Division of Water Supply Protection. The names have changed, but the mission of the Office of Watershed Management remains constant: to provide pure water through responsible land management.

CONTINUED ON PAGE 2



NUMBER 12
Spring 2005

Published by DCR Division of Water Supply Protection - www.mass.gov/dcr/waterSupply.htm

A New Look for Downstream - *Downstream* was initiated in 1999 by the managers of the greater Boston drinking water supply lands as a twice yearly publication to foster communication on common land protection issues with property owners in the Quabbin Reservoir/Ware River/Wachusett Reservoir watershed system. Greater interest in the nature of the Office of Watershed Management's work has created some changes to the *Downstream* newsletter: a larger audience, a wider scope of topics, and a new layout. *Downstream* now strives to present an expanded range of informative features promoting responsible environmental practices along with interesting topics and listings for family activities. The 100th anniversary of the Wachusett Dam in Clinton, MA is the focus of this edition. DCR Office of Watershed Management, as always, encourages public feedback on the information presented in this issue of *Downstream*, input on possible subjects for future articles, and general comments or concerns. See the back page for contact information.



In This Issue:

The New DCR	1
<i>A readers' guide to how we've grown</i>	
Building Wachusett Dam	3
<i>A very important Anniversary</i>	
Historic Photo Essay	4
<i>A visual account of building the dam</i>	
Watershed Education Program	7
<i>Raising environmental awareness</i>	
Kids Corner	7
<i>DIY watershed and see how it works!</i>	
From Concept to Reality	8
<i>Design alternatives for the dam</i>	

DCR - FROM PAGE 1

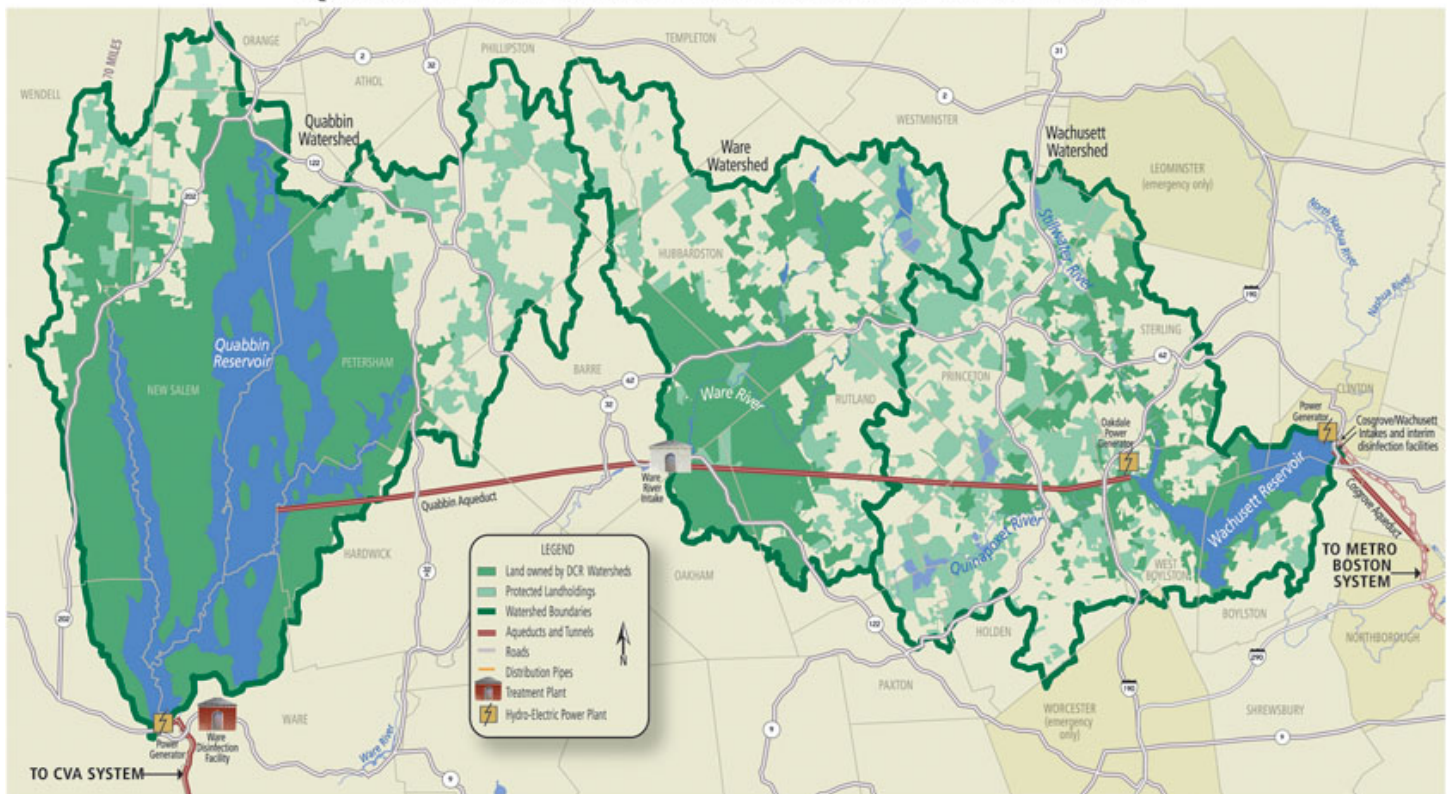
DCR's Office of Watershed Management is the steward of the vast water supply comprised of the Quabbin Reservoir, Ware River, Wachusett Reservoir, and Sudbury Reservoir watersheds. This watershed system provides the Massachusetts Water Resources Authority (MWRA) some of the highest quality drinking water in the country to treat and distribute to over 2 million citizens of the Commonwealth.

Chapter 149 of the Acts of 2004, s. 27, and written into the general laws at MGL c. 10, § 73. The trust provides a more efficient mechanism for MWRA's funding of the Office of Watershed Management. The Water Supply Protection Trust has a five person board of trustees, which is responsible for approving the Office of Watershed Management's annual work plan and budget; the members represent the

community officials and residents in this endeavor. Please visit www.mass.gov/dcr/waterSupply.htm for more detailed information about the activities of the DCR Office of Watershed Management.

-Joel Zimmerman, DCR/DWSP Regional Planner

Quabbin-Wachusett Reservoirs and Watersheds



There is a well established working relationship between DCR and MWRA. MWRA's ratepayers entirely fund the Office of Watershed Management's annual \$30 million budget, including costs associated with land acquisition and payments in lieu of taxes. The terms of this relationship are defined in a Memorandum of Understanding (MOU) between the two agencies.

The legislature further enhanced the ability of the Office of Watershed Management to maintain this drinking water supply by establishing a Water Supply Protection Trust, created by

executive director of the MWRA, the secretary of the Executive Office of Environmental Affairs, the president of the Swift River Valley Historical Society, the chairperson of the MWRA Advisory Board, and a member jointly selected by the North Worcester County Quabbin Anglers Association, Inc. and the Quabbin Fishermen's Association, Inc..

The dedicated staff of the Office of Watershed Management are committed to protecting these invaluable resources entrusted to them and working closely with the watershed

The DCR/MWRA System

Map courtesy of MWRA



A horse and buggy in the Wachusett Aqueduct while under construction.

Building Wachusett Dam

The City of Boston had nearly grown to the capacity of its water supply by 1892. Several of the communities surrounding Boston also found their water resources dwindling due to industrialization and increasing urbanization. It was evident that a comprehensive scheme would be necessary to ensure an ample supply of clean water. The following year, the State Board of Health investigated possible alternatives for a solution to this dilemma. The three most viable alternatives identified were: 1.) constructing an aqueduct from Lake Winnepesaukee in New Hampshire; 2.) capturing water from the Merrimack River; and 3.) damming the south branch of the Nashua River at a narrow pass in Clinton. After thorough studies, the state chose to construct a dam on the Nashua River, and thus create the Wachusett Reservoir, at that time, the largest man-made water body in the world.

The Metropolitan Water Works was established in 1895 by an act of State legislature to oversee the project. The dam location was 35 miles west of Boston, but only 12 miles from the Sudbury Reservoir System, the link into the metropolitan water supply. The board was given broad powers for construction, as well as land acquisition and transit route relocation. No firm cost estimate for the project was made, but the board was allowed to issue bonds up to \$27 million.

In order to provide water to a thirsty metropolitan area as quickly as possible, as well as facilitate dam construction, the first component of the system to be built was the Wachusett Aqueduct. Completed in 1898, the aqueduct was used to divert water directly to the Sudbury Reservoir System. This action temporarily reduced the flow of the Nashua River, not only providing needed drinking water to the state capitol, but also minimizing the challenges of building a temporary dam and diversion canal upstream of the site for the permanent dam.

The first contracts for preparation of the land that was to become the floor of the reservoir were enacted in 1897. Activities included tree and stump removal, razing of 378

buildings, relocating cemeteries, and stripping 3,943 acres of topsoil to a depth of one foot, leaving a clean gravel bed with little organic material. Soil removal was completed with the assistance of a small, three-foot gauge railroad that operated on 27 miles of track, utilizing 25 small locomotives and 725 open gondola cars. Over six miles of existing commercial railroad was re-routed to 4.5 miles of new track, including a new 1,100 foot rock tunnel adjacent to a 917 foot long steel viaduct. This viaduct would carry trains 133 feet in the air across the Nashua River Valley next to the new dam. The viaduct is now gone, but the supporting stone-work can still be seen today near the dam.

The new reservoir would be over eight miles long by two miles at its widest point with a surface area of 4,195 acres or 6.65 square miles. Reservoir capacity was planned to be over 63 billion gallons with a maximum depth of 129 feet and an average depth of 46 feet. As progress was made preparing the reservoir floor, construction of a temporary dam and containment weir were also under way. This temporary dam held back the flow of the Nashua River, while the weir carried the water past the construction site to a point further downstream.

Excavation for the Wachusett dam commenced in October of 1900, after the temporary dam was finished, and continued for just over five years. The dam was constructed of granite masonry and stretches 944 feet across the Nashua River valley. At its highest point the dam was 207 feet with a maximum thickness of 185 feet at the bottom and 22.5 feet at the top, just below the projecting cornice. The top of the dam rises 20 feet above the high watermark with a 452 foot weir to the west so that excess water could discharge back into the Nashua River. Four 48 inch diameter, cast-iron pipes pass through the dam, 111 feet below the high water level, with valves to control water flow to four hydroelectric generators located in the powerhouse at the dam's base. Granite rubble composing the dam was quarried about a mile away, but exposed facing was sheathed in Ashlar, quarried in Chelmsford, MA.

Laborers, mostly Italian and African Americans, worked year-round, primarily with hand tools, to build the

dam. Workers lived in "commissaries" or encampments, comprised of sod huts for sleeping and crude wooden dining halls. Hand labor was aided by two-wheel, one-horse carts to move material brought into the valley via a cable system suspended across the Nashua River valley from one of two sets of movable towers, mounted on tracks.



Laborers who worked on the dam were housed in sod huts.

Containment of the elevated water level was to be augmented by earthen dikes on each side of the dam. The dikes were partly composed of the spoils removed from the reservoir floor. The North dike stretches in two courses of 4,300 and 6,500 feet with a maximum height of 65 feet. The south dike is 2,800 feet long, with a height of 30 feet. Both dikes are protected from erosion along the reservoir shoreline with a 12 foot layer of stone rip-rap.

The last stone of the Wachusett Dam was laid June 24, 1905, while the North Dike was completed about 6 months earlier and the South Dike about 3 months later. Earth work preparing the upper edges of the reservoir floor continued for about two years after completion of the dam.

News of this engineering feat was heard world-wide. The Panama Canal Commission, looking for advice on their own construction project, toured the completed dam site on September 27, 1905. The dam and new reservoir were now ready to fill and serve the metropolitan Boston area with fresh clean water. Filling the reservoir took almost 3 years, reaching the high water mark for the first time on May 10, 1908.

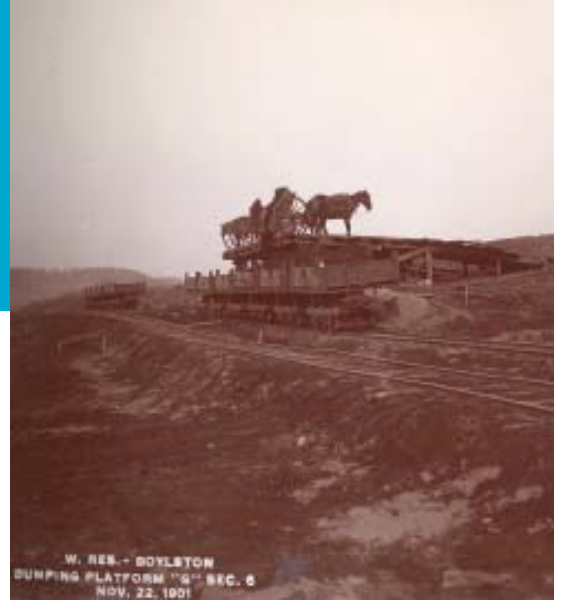
-Jim Taylor, DCR/DWSP Regional Planner

Images shown here were taken between the years 1899 and 1908 to document the creation of the Wachusett Reservoir. These historic photographs give a telling visual account of the challenges of building the dam, one hundred years ago, in the early 20th century.



Left: The site on the Nashua River, in 1899, where the dam is now located.

Right: A horse cart dumps soil into a railroad flat car. Trees, soil and organic material was removed from the floor of the reservoir during construction so that a clean gravel bed would remain.



Above Center: Laborer John Mercer lays the first stone for the dam in 1901.

Above Left: Workmen in the Boylston quarry. Most of the stone used to build the dam was cut here, but Ashlar dam facing was brought from Chelmsford, MA.

Below Left: Early progress to build the dam can be seen in the foreground. The long wooden structure spanning this photo is the weir that carried the flow of the Nashua River past the work site. The towers in the background moved along a track to bring heavy material into the site.



Right: This 1903 image shows the substructure of the dam that channels water from the reservoir into the Nashua River.



Below: This 1902 two-panel view of the Nashua River Valley shows the Old Stone Church, left of center, in its original setting.



Right: A train makes its way across the 917 foot steel aqueduct 133 feet above the Nashua River in 1908.



Below: A workman poses on top of a 48" diameter gate valve beneath the dam.



Right: The dam nears completion in April of 1904.

Below: Two days after the picture at right was taken, duct work below the dam is tested.



Left: The Old Stone Church sits on the bank of the new reservoir in 1905 as it slowly fills with water.



Above Right: Engineers consult as the dam cornice is about to be installed.

Left: The final cornice stone is laid on June 24, 1905. John Mercer is credited with overseeing this placement and is visible left of the stone.

Right: With completion of the dam, Clinton and Water Board officials tour the accomplishment with the engineer.



Building Wachusett Dam A Timeline of Events

July 19, 1895

Metropolitan Water Board organized.

January 29, 1896

First land purchased to build the reservoir.

March 7, 1898

Wachusett Aqueduct diverts water to Sudbury System.

October 1, 1900

Contract to build Wachusett Dam made.

June 5, 1901

First stone laid, by laborer John Mercer.

November 18, 1904

North Dike completed.



June 24, 1905

Last stone laid, by laborer John Mercer.

September 27, 1905

Wachusett Dam visited by the members of the International Board of Consulting Engineers, Isthmian Canal Commission (Panama Canal).

September 30, 1905

South Dike completed.

1906-1907

Soil stripping and the cleaning of the reservoir bottom continues as water gradually rises.

May 10, 1908

Wachusett Reservoir reaches high water mark for 1st time (395' above sea level).



View of dam upon completion. The numbers show annual construction progress.

The Story of Our Photo Source

The historic photographs seen on these pages are the result of a joint 3-phase project among seven organizations: the former MDC Archives and Div. of Watershed Management; MWRA Library & Records Center; Mass. State Archives; Boylston Historical Society; Clinton Historical Society; West Boylston Historical Society; and the West Boylston Beaman Memorial Public Library. The project, initiated in 2000, involves the restoration and digital reformatting of nearly 8,000 glass plate photo-negatives, as well as an additional 1,000 photos, documenting the activities of the Metropolitan Water Works from 1895 to 1926. The entire collection was in the possession of the MDC Water Division until 1965. The collection became divided at that time amongst the organizations listed above. This project brought the collection back together with the promise of restored image quality and improved accessibility.

Phase 1, completed during 2000-2001, entailed the archival cleaning and rehousing of the glass negatives and photographic images. Approximately 135 volunteers from the communities surrounding the Wachusett Reservoir watershed donated a day of their time to don white cotton gloves and carefully hand clean each glass plate under the close guidance of DCR's professional archivist. Nearly all the negatives have now been sequentially reunited. Efforts continue to merge approximately 700 related images still in the possession of other agencies with



Volunteers work carefully to avoid damaging the glass plate negatives.

the main collection that is now housed at the State Archives.

Phase 2, begun in 2001 and 90% complete by 2004, encompasses the data entry of subject information for each of these images into an electronic database. The database will be completed with the integration of the additional 700 images into the collection.

Phase 3 involves the digital reformatting of each image for both archival preservation and improved public access. Each of the originals will be safely preserved, while the story this collection has to tell will be more readily available to the general public. Funding limitations have left this phase of the project incomplete. These final steps, however, will remain a priority with the DCR archival department so that this truly impressive documentation of local history will ultimately be available to all.

-Sean M. Fisher, DCR Archivist.
Please contact him if you have any questions at 617-626-1440;
sean.fisher@state.ma.us.

"Building of Wachusett Dam" and "The Wachusett Dam Timeline of Events" was compiled and written by James Taylor, Regional Planner and Editor for *Downstream* from several sources including: *Metropolitan Water District (Boston and Vicinity)*, 1900; *Proceedings of the Convention of the American Water Works Association*, July 1906; *Ninth Annual Report of the Metropolitan Water and Sewerage Board*, 1909; *A General Description of the Water Supply of the Boston Metropolitan District*, Oct. 1940. The author would also like to thank DCR Archivist Sean Fisher and State Archives for access to the historic images and documents utilized in this newsletter.

And Another Thing...
by J. Taylor



A hundred eh?
How much is that in squirrel years?

Watershed Education at Wachusett Reservoir

This spring, education staff from the Office of Watershed Management's Wachusett/ Sudbury Section along with educators from DCR's Division of State Parks will offer a watershed education program for 4th graders in Holden and Princeton. Students will experience a series of activities focusing on watersheds, water supply, local history and forests. The lessons, activities and field trip incorporate science, math, social studies, history and language arts.

The participating teachers have previously been given training in this curriculum and are provided with the materials for each lesson. DCR staff will offer three different programs to the students at their school. DCR Watershed Rangers will present a slide program on the history of the Wachusett Reservoir watershed. Staff from DCR State Parks will provide a forest awareness session using literature and visual cues. The third activity, to be lead by DCR Office of Watershed Mgt. staff will utilize maps of



Local students participate in a field experiment with DCR Education Coordinator Jim Lafley.

the watershed to focus on the flow of water from the school to the ocean.

The final activity for the students will be a day-long field trip following the flow of water from Wachusett Mountain along the Stillwater River. On the trip, students will stop for more lessons and activities at Stillwater Farm and the Old Stone Church.

DCR will continue to offer this program on an annual basis in the Wachusett Reservoir watershed, and hopes to expand it to other area 4th graders.

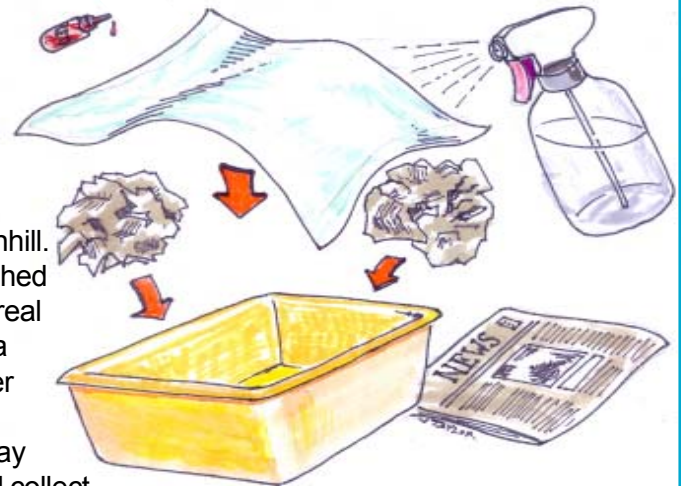
For more information contact Jim Lafley, Education Coordinator, DCR -Office of Water Supply Protection, West Boylston, 508-792-7423 x 231 or Jim.Lafley@state.ma.us.

KIDS CORNER

Building a Watershed Model

Everybody knows that water runs downhill. Simply put, a watershed is that hill, but in the real world, it's more like a bowl where the water can pick up almost anything along it's way downhill and it will all collect

at the bottom. If you hope to have clean water, you have to be careful about what that water may be able to pick up in it's travels. Here's a simple model you can build that demonstrates this.



The materials required to build your watershed are probably already around your home. Here is what you need: a wash basin, newspaper, white plastic sheet or bag, spray bottle, paper towels, blue and red food coloring. Help from an adult is recommended for children under the age of 8 years old.

A watershed can be very small, like the watershed for a puddle in yard, or very large, like the watershed for the Mississippi River. There is already a pretty good example of a watershed model in your house. If you go into the bathroom and turn on the shower, but leave the shower curtain open, where will the water go? The tub and the bathroom floor are examples of neighboring watersheds.

In our experiment, the wash basin will be used to contain a more detailed watershed model. The individual newspaper sheets are crumpled up to represent rocks and placed along the inside edge of the basin, leaving an opening in the center. Now take a plastic sheet or bag and place it over the "rocks" and push it down gently in the center, but leave the edges of the bag overlapping the sides of the basin.

The spray bottle, filled with water and a few drops of blue food coloring, is set on mist. The bottle, will be used to create a "rainstorm" in the watershed, but before beginning make some predictions and share your ideas with those who are helping you about what may happen. A "rainstorm" consists of spraying a couple of dozen times into your basin watershed. Now see what happens when it rains.

To add a more realistic feature to your watershed, add two attached paper towels placed over the top of the basin and pressed down gently in the middle and up against the sides. This represents the soil and plants of a real watershed. Before the next rainstorm, make some predictions about what will happen, let it rain again and notice what happens.

Now a drop of red food coloring is placed on the towel on a hillside and a third rainstorm is created. Again, discuss your observations. The food coloring dramatically shows the action of water in the watershed and can represent pollution.

Now consider the following questions think about pollution:

- ◆ What might the red represent? (It doesn't need to be something red)
- ◆ Could it be something natural? (Soil, tannin from trees or some other material)
- ◆ What type of pollution could it be and what might be the cause?
- ◆ What might spill in a watershed?
- ◆ How could you protect the watershed?

-Jim Lafley, DCR Educational Coordinator

Building Wachusett Dam - From Concept to Reality

Views shown here were produced before construction began in 1900 of the Wachusett Dam. The two sketches at the top depict alternative design proposals, the left showing a curved dam and the right showing a straight dam. Both of these proposals show the upper gate house located on top of the dam.



The lower drawing is a rendition of the accepted design built by the Metropolitan Water Works. In this design, the upper gate house is tucked out of sight and built into the top of the dam.

As an interesting side note, the artist of the accepted design, R.F. Elwell, became a famous fine artist. He was also widely known for creating artwork advertising Buffalo Bill's Wild West Shows.



DOWNSTREAM

**Department of Conservation & Recreation
Office of Water Supply Management
180 Beaman Street
West Boylston, MA**

(508) 835-4816 ex.363

***Downstream* is produced twice a year by the Massachusetts Department of Conservation and Recreation, Office of Watershed Management. It includes articles of interest to residents of the watershed system communities. Our goal is to inform the public about watershed protection issues and activities, provide a conduit for public input, and promote environmentally responsible land management practices.**

Governor:

Mitt Romney

Lt Governor:

Kerry Healey

EOEA Secretary:

Ellen Roy Herzfelder

DCR Acting Commissioner:

Stephen R. Pritchard

DWSP Director:

Jonathan L. Yeo

Downstream Editor

James E. Taylor